with ancient villages; The religious structures common to villages in prehistoric time, by *S. D. Peet.* An abnormal human skull from a stone grave in Tennessee; A new stand for mounting skulls, devised by E. E. Chick, by *F. W. Putnam.* Accidents, or mode-signs of verbs in the Iroquois dialects; Studies in the Iroquois concerning the verb 'to be,' and its substitutes, by *Erminnie A. Smith.*

PROCEEDINGS OF SECTION I. — ECONOMIC SCIENCE AND STATISTICS.

ADDRESS OF FRANKLIN B. HOUGH OF LOWVILLE, N.Y., VICE-PRESIDENT OF THE SECTION, AUG. 15, 1883.

THE METHODS OF STATISTICS.

I INVITE your attention to a few thoughts upon the *methods of statistics* — using the term 'statistics' in its broadest sense, as a 'statement of facts.'

The subject naturally divides itself into two distinct operations, — the collection of the data from which information is to be obtained, and their classification in a manner that shall without error, and with the least labor, present the results in a form most convenient for use.

Commencing with the first of these, — the collection of facts, — it would be needless to remark, that every thing depends upon the simplicity, accuracy, and completeness with which they are obtained, and that by no subsequent operation can their errors be eliminated, or their deficiencies satisfactorily supplied.

It may be remarked, in general, that no intelligent person, business firm, or corporation, can safely begin any enterprise, — nor can any government, from the lowest municipal to the highest national form, undertake any measure with prudence, — without first knowing all that can be ascertained beforehand concerning it.

In private business, inquiries are naturally made as to the cost and the profits. If it requires the use of a raw material, the parties will endeavor to make themselves sure as to its abundance, — the probability that the supply will be maintained, — or, if it be of limited amount, the quantity, and the time that it will hold out. They will need to know the changes that may happen in amount, quality, and cost; and similar inquiries will be made as to the expenses that may be incurred while in their hands, — the chances of loss, or of change in value, — and, finally, the extent of the demand for whatever may be the product of their skill, industry, and investment, its probable permanence, and its tendencies to change.

These questions, being well considered in the beginning, will enable the careful operator to avoid losses from imprudent investment, from over-supply of the markets, or from the depression of receipts below the limits of cost.

By a train of reasoning analogous to this, those intrusted with the government of towns, cities, or states, may determine as to how far the cost and maintenance of public enterprises will be justified by the results; but with this difference, that the benefits or profits, instead of being measured by a money value, are often to be found in an advancement of the public welfare, and in the security, convenience, and prosperity that may ensue.

But, whether in private enterprise or public undertaking, we may attribute success alike, in both, to an attentive notice of the facts and the circumstances upon which they depend; and, if loss or failure follow, the reasons may very generally be traced to ignorance or inattention as to the facts and probabilities that should have been known beforehand.

These thoughts lead us directly to the point we are first to consider; viz., How shall the knowledge of the required information be obtained? In the primitive way (and for a small business this may be the best one), the person will, from his own observation, 'look over the ground,' and consider the various points to be taken into the account. He will make inquiries of others, as to the supply, demand, prospects of competition, and the like; and thus accumulate a certain amount of information, upon the extent and accuracy of which, his success or failure will in a great degree depend.

Advancing a step farther, we find, in most great industries and interests of the country, that those in the same business or pursuit, whether in the arts or sciences, or in financial operations, however they may be influenced by local rivalries or petty jealousies, are constantly tending to the formation of associations or societies, for the advancement of their common interests. They meet for the discussion of methods by which expenses may be saved, or profits increased. They inquire of one another as to their experience or observation upon doubtful points. They seek to gather light and aid from science, to stimulate and reward invention, and to excite rivalries in the comparison of improved products. They discuss financial and national questions that may affect their welfare; and not unfrequently they appoint committees or agents, from their own number, to gather statistical facts and details for their own use and guidance.

We consider the information thus obtained, as deserving high rank in point of accuracy. It is chiefly taken from records, without a motive for concealment or evasion, and with a full knowledge that self-deception and loss would result from error, whether above or below the truth.

From this combined experience, each member who participates obtains a standard for comparing his own results with the general average. He cannot afford to fall below it, and he has the strongest motives for reaching the highest limits that have been reached by others.

Still these statistics, however accurate they may be, are necessarily special, and often technical in their nature. They cannot be compared with those

of another business, and may be incomplete within themselves, as naturally relating to methods, rather than to financial details. They might show *how*, rather than *how much*. They will seldom contain a balance-sheet of profit or loss, or any thing that would advance the fortunes of a rival in business, or reveal the secrets of an unprofitable enterprise. We must receive them as we find them, — good only as far as they go.

Besides these associated business inquiries, prompted and guaranteed by self-interest, we find various others, voluntarily undertaken with reference to particular subjects, often for the promotion of a moral, religious, benevolent, educational, or political object, and ranging in value all the way between the accuracy of statements taken from records, or gathered by faithful inquiry, by chosen special and zealous agents on the one hand, and the random conjectures carelessly returned by those who know but little, and care still less, about the subject of inquiry, on the other. It would be wholly impossible to assign a scale of value to statistics thus obtained, where every thing depends upon the circumstances of the case, and the accuracy of information on the part of those who make returns, — the fulness with which they are reported, and the care with which they are combined.

We have another class of non-official statistics collected and published by private enterprise, for the information of particular trades or professions, or for use by the general public; their reputation and success depending wholly upon their accuracy, and being brought to the test of local and personal knowledge every day and everywhere, we may naturally expect them to be as accurate as they can be made. In this class, we may include directories, trade and market reports, financial transactions, and the current commercial statistics generally.

There may be instances where they are tainted with a suspicion of private or speculative motive: but such is the vigilance of rival enterprise, that detection will quickly follow; and an exposure would at once degrade a reputation for independence and impartial statement, to the rank of a private job for a speculative end.

Exhibits openly made, for the avowed purpose of presenting the favorable side of a business enterprise, may be taken for what they are worth, and are often trustworthy; but, when concealed under a false pretence, they deserve suspicion, and, when exposed, they generally injure the interest that they represent.

The best of these statistics are taken from records, and are entirely correct; others are collected by special agents, and should be approximately near the truth; and there is still another class, made up from the estimates of those supposed to know the facts, and which must wander more or less from the actual conditions that they attempt to represent.

It may be said of all of them, that their greatest value is for present use. They quickly pass by, to give place to the next issue, and remain only as historical records; but, as such, they still afford a most valuable means of comparison between the present and the past, and become landmarks of progress, ever instructive to those who may be seeking to trace the origin and growth of our industries and our resources; and now and then they are recalled as precedents, where new questions arise, under circumstances deemed similar to the past.

We will next consider some points relating to inquiries undertaken by authority of government, either for the intelligent discharge of its own functions, or for general information, the good of its citizens, and the advancement of knowledge among mankind.

We may, in general, remark, that nothing can be properly done, in the machinery of government, without leaving its record. If money or property is received, there is an entry; if a payment is made, or if property is issued, there is also an entry, and a receipt to prove it. In short, the whole theory of our government involves the necessity of a record of every official transaction; and it is only in cases of intentional fraud, or gross neglect, or unavoidable accident, that the history of every public act cannot be traced from these records.

A record, to be trustworthy, should be made at the time of the transaction, and while all the facts as to time, subject, and amount, or other points of statement, are fresh in mind. Nothing should be trusted to the memory, and for record at a more convenient season. It should be concise, and easily understood, and may often be very greatly assisted by tabular arrangement.

The summaries of these records, as published by the government, are, we believe, with few exceptions, entitled to great confidence, as far as they present transactions done by authority, or passing under the notice of government agents.

We may classify the official statistics of the government under the following heads: —

First, Summaries of current business, published annually or at shorter intervals.

Second, Periodical inquiries made at wider intervals, as in the census, and requiring special agencies for their execution.

Third, The inquiries made by experts, or by special commissions or agencies created for a particular purpose. This class is sometimes associated with one or the other of the preceding.

Taking from among these classes the census, as one of the most important, let us notice some of the methods by which it has been taken.

Ths earliest returns that I have found, in colonial times, were made by sheriffs and constables. At a later period, the national census was for a long period taken by the marshals of the district courts, or their deputies, — officers whose duties are quite analogous to the former; and this practice of assigning the task to sheriffs still prevails in several of the states.

In many other cases, assessors discharge the duty. In New York, before 1855, special agents were appointed by local authorities; and, commencing with that year, they have since been appointed by the secretary of state. The appointing power has been vested in state boards, in boards of county commissioners, and in the judges of inferior county

courts. Assuming what I think all will admit, that census inquiries should be made entirely free from any suspicion that some tax or some personal liability is to be incurred, it is evident that an assessor cannot question an ignorant man about his property and his crops, without exciting his fears that some tax is to be laid. The sheriff or the constable seldom makes a professional call, except to serve some papers or make an arrest. There is, therefore, a strong reason for appointing persons who are to make the census inquiries their only business, and for making it widely known that there is no taxation, enrolment, or other liability incurred by giving full and true returns, and that there is no sectarian or political end to be served by the inquiry.

This excellent end is now well enough secured under the national law, and in several of the states. They have a still better method in Great Britain, where a system of registration of births, marriages, and deaths, has its districts and its agents under constant organization, and to which, once in ten years, the census can be assigned, without creating new offices. In Sweden, where a system of registration, including also a record of change of residence, is in charge of the parish-clerks, they take a census whenever they choose to post the books, without any special inquiries being made, more than what these records contain.

In the national census before 1850, — in New York before 1855, — and in some of the states still, each family had one line upon the blanks; and the number of persons of different ages, sexes, and colors, was entered in columns provided. The limit of classification was of course restricted to these columns; and, although the totals of each class were easily obtained by adding, the results were meagre and unsatisfactory.

The change that allowed a line for each name, one column for the exact age, and other columns for native country, profession or occupation, etc., while it simplified the labor of taking, allowed ample field for classification; and it made it necessary to employ a large force of clerks, in a central office, for the reduction of the returns for publication.

By a method now generally used in Europe, the census is taken upon 'householders' schedules,' which are distributed one to each family, some days beforehand, filled out by the head of the family, and collected upon *one day*. The only instance in which this has been done in the United States, within my knowledge, was in the District of Columbia, upon the 11th of November, 1867. This census was taken by the metropolitan police, under my own direction, and with entire success. It was attempted in the city of Baltimore some months afterwards, and failed, apparently from want of proper management on the part of those in charge.

For all kinds of official inquiries, relating to business, as well as to personal statistics, I think the true and proper method is, by means of *special blanks*, carefully prepared, simple, and fully explained. These should be distributed some little time beforehand, and should be taken up, if not in one day, within a short period of time, but with reference to a given day. The chief difficulty to be encountered is the illiteracy of those who should fill the blanks; but in the District of Columbia, which in 1867 contained a large number of colored families, but recently freed from slavery, the blanks had been, in almost every case, filled out by some one to whom they had been carried.

In following our subject, — the 'methods of statistics,' — we may notice some points in the condensation and arrangement of facts that may be of interest.

With a vast amount of information before us, as, for example, in the returns of a census, let us consider what is to be done, and how it can be done with the least labor and greatest certainty. After inspection to make sure that the work is all together, in proper order and condition, it will be found that several distinct operations are necessary, in preparing the results for the press. Columns of figures must of course be added, and carefully revised. As the totals of several sheets will often be consolidated into one sum, it is best to use spare sheets of the same schedule for entering the totals of pages, so that these partial totals can be easily combined. It is always a good practice, where long columns, of many figures in each, are to be entered for adding, to provide paper with narrow vertical ruling, that shall allow of but one figure in a space. In cases where the first two or three right-hand characters are generally ciphers, they may be left out altogether, the significant figures only being entered in their proper places. It saves a little time and labor, and does not lead to error.

Where a great amount of statistical material is reported, — as, for example, the names in a census, — the blanks should always be plainly divided by horizontal and vertical lines, *printed in preference to ruled*. The horizontal lines should be numbered from the top downward, upon both margins. This numbering is the more important where an entry is carried across to another page. Each line should contain but one entry, and there should be, if possible, no blank lines except at the end. Then, with a little multiplication-table at hand, showing the number of lines in a full sheet, and for each number up to the highest that are likely to be found in a return, the totals can be rapidly and accurately ascertained, as follows: The number of sheets is first counted on the back edge, and the number of entries they should contain, if full, is set down. Then, by glancing over each page separately, it is easy to notice whether there are any lines with two entries, any blanks, or any lines in excess. The deficiencies are set down in one column, the excess in another, and their difference is added or subtracted, as the case may require, when the true sum is at once found. This operation, which is the first thing done, should be repeated by another person; and, when found to agree, it should be kept as a test-number for verifying the accuracy of much of the work that is to follow. In measuring parts of pages, a scale made of a strip from the margin of a blank schedule, and pasted upon a card, will save all labor of counting.

In statistical labors, where the same returns afford

material for a considerable number of deductions, — as, for example, the population sheet of the census, — it is generally best to take *but one thing at a time.* Thus, the ages, professions, nativities, civil condition, etc., should be taken by separate operations, and not two or more at once. There is not, however, the least need of confusion in keeping the subdivisions of these subjects, in two or four classes, — as, for example, ages by sex and color, — by a simple arrangement of heavy and light horizontal lines upon the tally-sheet, and a little practice in its use.

There is much to be gained, both in time and accuracy, by a proper arrangement of a tally-sheet. The grouping together of tally-marks, by making four down and one across, so as to divide the work into groups of fives, is so natural and obvious a method, that few who have had occasion for this kind of work could have failed to adopt it. By an arrangement which I have used to a large extent in census work, I have had my tally-sheets printed off into squares, so that each compartment should receive one group of five, and no more. Then, by a series of numbers with a common difference of five, printed across the top of the sheet, at the head of each vertical column, the number of tally-marks in a horizontal row can be known at once, by glancing along the vertical column containing the last full group of fives, to the number printed at the top, and then adding the marks in excess, but less than five, in the next compartment. This saves all counting, and a considerable amount of time. There is also an advantage, on account of the eye-sight, in having the tally-sheets of some other color than white: a neutral tint might be best, but I have found common manilla paper answer every purpose.

Plans have been proposed for using cards of different sizes and colors, properly inscribed or numbered, as counters, for classifying a variety of facts, forming together a definite whole. By using colors, the eye becomes, without mental effort, a guide to the hand, in their distribution into piles or cells in a case; and, when the work is done, their number may be accurately known by weighing, or by measuring the height of each pile. Those of different sizes could be separated by mechanical devices, without handling, and, by a little practice, without liability to error.

It may be said generally, that the chief, indeed the only real, difficulty, in the preparation of statistical data, consists in getting the facts correctly. There is nothing in the operation of a central office that needs to involve error; or, if an error is committed, there should be no difficulty in tracing it to the clerk who is responsible for it. An efficient way to secure accuracy in work would be, to make a money-charge against the clerk who commits an error, to be paid to the one who finds it. I believe that something of the kind is done in some of the statistical offices in Europe, a class of revisers being employed, who are paid by the fines thus imposed upon the careless.

With respect to statistics obtained by circulars addressed to persons supposed to have the information desired, we have every grade of value, from good to good for nothing. The result depends upon many circumstances: as, for example, whether the person making the return is paid, or is under some obligation to, or expects some favor from, the person or office making the inquiry; whether the inquiry can be answered by reference to a record, or by some research more or less conveniently made, or is to be supplied from personal opinion, and a general knowledge of the subject; or, finally, whether the question can be answered by any thing better than a guess, by one who knows perhaps very little about it.

I would hold it to be the general rule, that where the inquiries are few and simple, exact as to their object, and, if they refer to a record, exact as to time and subject, and especially if they can be returned upon the same blank, and without expense for postage or otherwise, a very large percentage will be answered without a second application. A repeated call would probably bring a third or a half of the remainder; but there will be, now and then, one who will fail to reply, unless under official or personal obligation to do so.

We have thus far considered the dealing with statistics that have been gathered from the whole of a given field of inquiry: there are other methods that deserve notice, and the first of these is that 'by samples.' A portion of some whole is carefully studied, and the results obtained are deemed applicable to the entire field.

The French statistician Moreau de Jonnès has given some instances of this method, as applied in times past, by persons who had acquired eminence, and whose work gained confidence; and very properly asks, 'What is such work worth?'

Vauban, distinguished as a military engineer, at the beginning of the eighteenth century, wishing to know the agricultural production of France, and the revenue it would yield, resorted to a method which would appear strange enough now, but still may be called ingenious. He attempted to reach his object by taking an exact account of the production of a square league, reckoning the arable land, vineyards, pastures, and woodlands, with their products in quantity and value; and then, by the simple "rule of three," he said, "as 1 is to 25,000, so is the result to the whole of France."

The English agriculturist, Arthur Young, sought to ascertain the proportions of meadow-land, mountains, and the like, in France, by cutting up a map by lines following these features of the surface, and weighing the parts.

In 1790 Lavoisier, distinguished in science, and for this reason consulted by the national assembly upon a question of imposts, found no existing data that applied to the internal resources of the country, until he himself supplied them, by a method that is now altogether neglected in statistical researches. He proposed to ascertain the number of ploughs in the country, and from this to calculate the quantities, production, and consumption of agricultural crops.

In 1784 M. Necker, the distinguished statesman, deduced the population of France from an assumed percentage of the birth-rate; and this was taken for a census!

But coming down to a much later period, we find a remarkable application of the law of induction in a work upon the industries of France, by the minister Chaptal. He presents agricultural tables, which have been received with great confidence, since they bear the appearance of official statistics, and were executed under the Empire. His tables are found to have been computed, without acknowledgment, from a statement addressed by M. Hennet, director of the cadastral survey, in 1817, at a time when not more than a seventh part of this work had been finished. The other six-sevenths were obtained by a simple multiplication of the finished part.

Many years ago, a 'distinguished statistician' published, with great apparent precision, the yield of potatoes in France. There had been no official inventory taken; but when one came to be made, some time afterwards, it was found that this deduction had been obtained by mutiplying the yield of a single commune by 37,000, the number of communes in France.

These examples might be multiplied indefinitely; and we need not cross the Atlantic, nor go far back in time, to find them. There is scarcely a day, but that we see passing through the newspapers, estimates, deductions, and statements, that have no more solid foundation than those that we have cited. Nevertheless, we must not wholly disregard the inductive method in statistics: there are many cases in which we can get nothing else.

The chemist must analyze the soils and the ores from samples. In every operation of testing the quality and the value of any commodity whatever, we must select from the material before us what appears to be the average quality. And so of statistics generally: if there is no actual and general inventory made, we must collect from what is deemed a fair average, and, from these data, obtain such conclusions as they afford. The result in this, as in every thing, will depend upon the intelligence and honesty of the person who makes the estimate, the extent of his opportunities, his experience, and his skill.

Returning to the field of exact statistics, we may remark, that we can never have an accurate census of the population until we have a thorough and uniform registration of births, marriages, and deaths; a measure which this association undertook to promote, more than a quarter of a century ago, but which has not made successful progress.

We cannot have a faithful statement of the industries, without a record kept of the production, the consumption, and the cost of operation. This is already done by most of the important ones, as an incident of business; but we lose the advantages by the hurried manner in which the official inquiries are made. Yet upon these returns we rely for all that is collectively known about them.

It follows, that, until we can realize these desirable features, the best we can expect is, to afford more time for previous preparation, by submitting beforehand the questions that are to be answered; which can only be done by the aid of 'householders' schedules' for population, on 'special blanks' for each of the industries, or other subjects, that come within the range of inquiry.

It was my intention to dwell at some length upon the illustration of statistical facts by graphic methods; but time will not permit, and opportunity for full preparation has not been found. For more than thirty years I have been accustomed to note down the principles involved in these methods, whenever, in the course of a wide and varied range of opportunity, a new one was found; and it has been with me a cherished intention to present the whole subject in a systematic form.

We may concisely state, that graphic illustrations, using lines, areas, or angular spaces, often supplemented by colors, may be employed for representing either —

1. *Quantities*, with or without reference to time.
2. *Time*, in recurring, interrupted, or progressive periods.
3. *Direction*, or *relative position*; and
4. *Intensity* or *force*.

In general, but two elements can be clearly presented at once; but by a skilful use of different colors, or kinds of lines, subjects of the same nature may be admirably compared, and the relations of cause and effect not only illustrated, but even discovered and proved. It is often admissible to introduce subjects having dissimilar notation, — as, for example, degrees of temperature, and height of barometer, — in the same drawing; but in these cases each must have its own scale, and, in a general way, every diagram must have a scale for every element of the subject that is represented, either expressed or implied.

Quantities may be shown either as they exist at certain periods of time, or as they form parts of a general total; and they may be presented so as to exhibit successive subdivisions, down to any desirable degree. If the divisions of a general total do not require subdivision, they may best be shown by angular spaces, as sectors, which together make up the whole of a circular area. If the divisions have some qualities in common, the shades of color may be of different intensity, significant of the degrees of quality that may exist. But where there are successive subdivisions, or *parts of parts* of a whole, there is no way so exact as by means of rectangular areas, which may also be shaded in different tints, as well to separate them one from another as to show differences of intensity or degree.

In both of these methods, as well of angular spaces as of rectangular areas, we can only show quantities as they exist at a given point of time. We catch, as it were, the conditions, as does the light, the image in a camera. They admit of no such thing as motion or change; but these changes may often be strikingly represented by a series of diagrams, presenting the conditions at different periods of time.

Where time and quantity are combined, we have an easy and striking means of illustration; and in this the time may be in recurring periods, such as the hours of a day, or the months of a year, or it may be progressive, as in a series of years.

For the recurring periods, I think there is nothing

so convenient and instructive as the *circle*, in which the quantities are measured along the radii, from the centre as their base. The entire radius may sometimes represent the whole of that of which these partial measurements are a part.

For a progressive series, the ordinates representing quantities should be measured from a level base-line, and the scale of graduation shown upon the side margin, while the time is measured from left to right by a scale along the upper margin.

For simple comparison, a series of bars or lines, measured from a common base, and either horizontal or vertical, is a convenient and striking mode of illustration, and has now come into very common use.

A rectangular area, with parallel divisions, amounts to the same thing as a line; but with this difference, that a secondary subdivision may sometimes be represented with great effect.

Having thus stated some points in reference to graphic illustrations upon a true principle, I should not leave the subject without a word of censure for some that are false. I will specify, particularly, such as attempt to represent comparative quantities by *concentric figures*, such as circles or squares. The eye has, in these cases, no means of just comparison; and they are very apt to mislead, where they are intended to instruct.

The same objection may be made against similar geometrical solids; for, although they may be literally true, their contents being to each other as the cubes of similar lines, the eye does not readily see the difference. It would be better, in such cases, to use cylinders or prisms of the same base, but proportioned in length to the quantities that they represent.

PAPERS READ BEFORE SECTION I.

Life-insurance and self-insurance.

BY ELIZUR WRIGHT OF BOSTON, MASS.

THIS subject has been a favorite theme with Mr. Wright for several years. His ability as an actuary is acknowledged; and his theory on this subject has at least the merit of disinterestedness, so far as insurance-companies are concerned. Without going into the technicalities and mathematical considerations that must be met in a thorough review of Mr. Wright's theory, its object may, perhaps, be stated correctly in a few words. A reserve is accumulated by the practical workings of life-insurance in a well-regulated company, which is more than sufficient to meet the claims upon it as fast as they mature. The usual system divides that reserve, less the amount which the company withholds as a surplus for extraordinary emergencies, among the policy-holders. Mr. Wright takes the view that each policy earns, during its continuance, an ascertainable part of that reserve. He supplies the means for determining what this part is, for each policy: of course, it is a matter of calculation for each. He denominates this part of the reserve, or surplus, the 'self-insurance.' By his system it is possible to ascertain at any time how much this self-insurance on a given policy amounts to, or how much it will amount to at any future time, if kept in force. Mr. Wright believes that the self-insurance is the property of the policy-holder; and that, if not payable to him on demand, it should at least be applicable for a renewal of the policy to prevent forfeiture.

The increase of the colored population of the United States.

BY C. S. MIXTER OF WASHINGTON, D.C.

IT is frequently asserted that the colored population of the United States is increasing more rapidly now than it did prior to 1861. The large apparent increase shown by a comparison of the census-returns of 1880 with those of 1870 seems to justify this opinion; but the results of investigations made by the superintendent of census in South Carolina and Mississippi show that the census in 1870 was seriously defective in this respect, while that of 1880 was very full and complete. The accompanying statistical table presents the returns of these people according to each U. S. census from 1840 to 1880, and gives the numbers reported from the South in detail. These results seem to indicate that they are not increasing as rapidly as formerly. The burden of supporting their minor children, and their disregard of the rules of health, seem to furnish additional reasons for thinking that their future rate of increase will be less than it has been heretofore.

Resided in	1880.	1870.	1860.	1850.	1840.
Alabama	600,103	475,510	437,770	345,109	255,571
Arkansas	210,666	122,269	111,259	47,708	20,400
Delaware	26,442	22,794	21,627	20,363	19,524
Dist. of Columbia .	59,596	43,404	14,316	13,746	13,055
Florida	126,690	91,689	62,667	40,242	26,534
Georgia	725,133	545,142	465,698	384,613	283,697
Kentucky	271,451	222,210	236,167	220,992	189,475
Louisiana	483,655	364,210	350,373	262,271	193,954
Maryland	210,230	175,391	171,131	165,091	151,815
Mississippi . . .	650,391	444,201	437,404	310,808	196,577
Missouri	145,850	118,071	118,503	90,040	59,814
North Carolina . .	531,277	391,650	361,522	316,011	268,249
South Carolina . .	604,332	415,814	412,320	393,944	335,314
Tennessee . . .	403,151	322,331	283,019	245,881	188,583
Texas	393,383	253,415	182,921	58,538	–
Virginia	631,616	512,841	527,763	526,861	498,829
West Virginia . .	25,886	17,980	21,144	–	–
Other States . . .	481,540	341,127	226,219	196,570	171,857
Total U. S. . .	6,580,793	4,880,009	4,441,830	3,638,808	2,873,648

Oyster-farming in Connecticut waters.

BY H. C. HOVEY OF NEW HAVEN, CONN.

AN explanation of the difference between seed oysters and those fit for market gave the author occasion to mention that 'saddle rock' oysters in their best edible condition were six or seven years old. A history of Connecticut experience and legislation in relation to oysters was given in detail. There are now 325,000 acres of disposable space for oyster-beds, and 100,000 are occupied. The area of the natural beds is only 6,000 acres, and this furnishes

the seed for new beginners. The present expansion of oyster-farming is due to the use of steam-power in gathering the harvest.

The first thing done on an oyster-farm is to stake it out into sections, and then the bottom is examined. The next step is to scatter oyster shells over the farm, and the oyster spawn is scattered. After this, in some muddy localities, small trees, mainly birch, are thrust into the water, in a standing position; and the young oysters set on these trees. The spawn is cast out from June until November, and for a few days the young oysters swim everywhere they please, leading a happy life for a brief period. Shelling begins about June 15, and ends about Aug. 15. When the oysters fill the trees, the latter are pulled up and cleaned off. From one acre of bushes, 1,000 bushels of oysters have been gathered in one year. The oysters set on anything which is clean. They had been found on old boots, old wrecks, and a pair were found on an old padlock. Oyster-farming was not profitable every year; one firm having lost $20,000 by the ravages of the star-fish in one bed, and another firm $100,000 in two years from the same cause. Oysters were formerly imported, but are now exported in immense quantities.

The German carp, and its introduction into the United States.

BY C. W. SMILEY OF WASHINGTON, D. C.

THE United States fish-commission, he said, had some years ago imported from Germany thirty or forty pairs of this fish. They were placed in breeding-ponds in Washington, and have increased many-fold, the number spawned this year being 400,000. The carp is naturally a warm-water fish, and in the waters of the southern states grows with astonishing rapidity, and to great size. They will also do well in the cold water of the north, even in Minnesota. Nearly every state and county in the United States has a fish-commission, and they are all propagating carp. It has also been taken up as a private speculation, and carp are sold for breeding-purposes as high as $5 per pair.

The carp roots about in the mud for aliment, and much resembles poultry in its manner of getting food. Carp aged three years are often found to weigh twelve to fifteen pounds, and a gain in weight of four pounds has been observed in a carp in one year. The carp is sluggish; while trout, bass, and other lively fish frisk about, and do not fatten so fast as the carp. Experiments have shown that female carp spawn at the age of one year in southern waters, at two years in colder waters, and in the extreme northern waters of the United States at three years. Other fish, turtles, muskrats, snakes, and even birds, eat young carp. A bird shot in Washington recently had in its stomach the heads of seventy-nine young carp. The U.S. fish-commissioner recently sent out requests for information about carp experimented with in this country; most of the replies placing the carp on an equality with trout, bass, and shad as a food fish, while a few classed them with pike, and a very few said they had a muddy taste. The carp is the best pond fish yet known, and in a very small pond will thrive well, so that families may easily have their own fish-garden if they have enough water to make a permanent pond. The carp is a very hardy fish for shipment, requiring little water to keep alive in. The U.S. fish-commissioner is giving away carp, sending them by express to any point, the receiver paying express charges. The fish will thrive on table-refuse and almost any thing edible. Carp can be kept in winter in a tub in the cellar, the water requiring to be kept fresh. Care should be taken to keep poisonous substances out of carp-ponds, and too much food should not be thrown in. In cooking carp, thorough cleansing is needed; and frying should be done in hot pans and hot grease.

As to the economics of this subject, Mr. Smiley said that fish-culture was more and more becoming a part of the farmer's occupation, and thought that, not very long in the future, most of the farmers of the country would have little fish-ponds in their door-yards, both as a method of obtaining food and as an ornament to the homestead.

Cable-cars for city passenger traffic.

BY E. T. COX OF NEW HARMONY, IND.

PROFESSOR COX, though devoted to geology, has always taken a kindly interest in schemes for industrial advancement. In the present paper he describes the success of the cable system as a substitute for horse-cars; and urges its general adoption, on the ground of its convenience and comfort to humanity, as well as the diminution of suffering to the horse. Some of the collateral statistics presented in the paper are interesting; e.g., the figures given by Mr. Moody Merrill, chairman of the horse-car railroad convention held at Boston last March: "There are in the United States and Canada 415 street-railways, giving employment to about 85,000 men, 18,000 cars, and 100,000 horses in daily use. These horses consume 150,000 tons of hay, and 111,000,000 bushels of grain. 3,000 miles of track represent an invested capital of $150,000,000. The number of passengers annually carried is 1,212,460,000. In the city of New York there are 110 miles of horse-railway, and 11,866 horses are used to operate them. The horses, together with their harness, expensive lands and stables, feed and grains, make the operating expenses, by including interest, $5,104,596.79 per annum. The average life of the street-car horse in New York is less than three years."

The paper quotes an opinion of Gen. W. Sewell of New Jersey, a practical railroad engineer, who prophesies that, within ten years, the cable system will supersede horse-cars on every considerable street line. The great advantage of the system is its applicability to very steep grades. The paper states, in respect to the most vital question to capitalists, that the cost of the plant in the cable system is shown to be about $70,000 per mile of roadway. We have heard it recently stated, in other quarters, at $120,000; but perhaps one estimate applies to single and the other to double tracks. This makes it, at best, some-

what expensive as an experiment; and that is the light in which it is regarded by many horse-railroad managers at present.

Improved method of spraying trees for protection against insects.

BY C. V. RILEY OF WASHINGTON, D.C.

THE paper gave a summary of results obtained from experiments made during the past two years at the U. S. department of agriculture. An ordinary barrel is used as a reservoir, in which is inserted a force-pump with automatic stirrer. A long rubber hose extends from the pump, and is attached to the spraying apparatus. The nozzle has been called the cyclone or eddy nozzle; its action carries out new principles of spraying. It is a shallow, circular, metal chamber, with two flat sides, in the centre of one of which is a small circular outlet. The fluid is forced into this chamber tangentially, producing rapid rotation, and a spray which is easily regulated from a mist scarcely visible to a strong shower. This nozzle is adjusted to the end of a bamboo rod (of varying length, according to requirement), through which the rubber hose has been passed; or several nozzles may be attached, in different positions, to the sides of a stiff metal tube, sufficiently slender to be handled by the operator, and thrust among the branches of the tree. By these means, trees from twenty to thirty feet high can be rapidly sprayed without the use of a ladder. The substances used are either London purple, one-half pound, and flour, one pound, in from forty to fifty gallons of water; or Paris green, one pound, to the same amount of flour and water; or petroleum emulsions made as Professor Riley indicated at the last meeting of the association.

Enhancement of values in agriculture by reason of non-agricultural population.

BY J. R. DODGE OF WASHINGTON, D.C.

THE paper begins by showing that national industry is prosperous in proportion to its diversity. The productions of agriculture would be unsalable if all the people were agricultural producers. A civilized nation, with the smallest proportion of non-agricultural workers in it, will be low in the scale of prosperity: with the largest proportion of non-agriculturists consistent with proper food-supply, the nation will be most prosperous. To a great extent, this is true also of the subdivisions of this country. It may be illustrated by the statistics of geographical sections that embrace groups of states, or by comparison of individual states. The author is even prepared to show, that, in a partly agricultural community, the increased employment of labor in industries that are non-agricultural stimulates improvement, compels higher culture, and makes the products of land, and the land itself, more valuable. Such is the theory. In support of it, the author adduces striking facts, obtained by compilation from U.S. census returns of 1880.

The states and territories are grouped for this comparison in four classes, which are thus designated: first class, having less than 30 per cent of agricultural workers; second, having over 30 and less than 50 per cent; third, having 50 and less than 70 per cent; fourth, having over 70 per cent, *i.e.*, being almost exclusively agricultural states.

Classes.	No. of states and territories.	Acres.	Value.	Value per acre.	Per cent of workers in agriculture.
First class . .	15	77,250,742	$2,985,641,197	$40.91	16.59
Second class .	13	112,321,257	3,430,915,767	22.21	40.12
Third class .	13	237,873,040	3,218,108,970	13.03	58 85
Fourth class .	6	108,636,796	562,430,842	5.28	77.46

In the first class are Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania in the east, and some of the mining states and territories of the west, diverse in many points, yet alike in the fact of a large non-agricultural population. This class has only one-sixth of the population in agriculture. The fourth class consists of North and South Carolina, Georgia, Alabama, and Mississippi. It has nearly four-fifths engaged in agriculture, on lands worth only an average of $5.28 per acre. The states having only two-fifths in agriculture have farm-lands valued at $22.21 per acre, while those having nearly three-fifths in agriculture have lands valued at $13.03. These figures speak for themselves, and scarcely need comment from the author.

When individual states are compared, the results are equally marked. The author compares pairs of states, — Virginia and Pennsylvania, Kentucky and Ohio, Iowa and Illinois, — as follows (for convenience we place these comparisons in tabular form): —

Items of comparison.	Virginia.	Pennsylvania.	Kentucky.	Ohio.	Iowa.	Illinois.
Per cent of agricultural workers	51.41	20.68	61.67	39.97	57.46	43.65
Value of farm lands per acre	$10.89	$49.30	$13.92	$45.97	$22.92	$31.87
Wages of agricultural laborers per annum .	180.00	431.00	199.00	394.00	[1]	467.00

Similar computations give figures for the State of New York not widely different from those for Pennsylvania. The average value of farm-lands per acre in New Jersey is greater than in any other state, viz., $65.16: this is owing to a position between two great city markets, with proximity and easy access to both. Her percentage of agricultural workers is only 14.92; their average annual wages are $501. It will be seen that the wages of agricultural labor are subject to the same law. If computed for the first table in this paper, the wages per month of the agricultural

[1] The annual wages of agricultural labor in Minnesota are $376.

laborer would be found, for the first class of states, fully $25; for the second, nearly $25; for the third, less than $20; for the fourth, about $13.50.

An application of the same test to the value of annual production for each man engaged in agriculture brings equally interesting results in the following table: —

Classes.	No. engaged in agriculture.	Value of products of agriculture.	Value per capita.	Per cent of workers in agriculture.
First class . .	1,060,681	$484,780,797	$457	16.51
Second class .	1,566,875	616,850,959	394	40.12
Third class . .	3,017,971	786,681,420	261	58.85
Fourth class .	2,024,966	325,099,388	161	77.46

The states with less than 30 per cent in farm-labor realize nearly three times as much per man as those which have over 70 per cent in farm-work. In other words, one man in the first class realizes as much as the three men who are competing with each other, having little outlet for surplus production. Three brothers in Alabama, laboring through the year, get as much for their aggregate produce as one farmer receives in Pennsylvania, simply because that farmer has a brother engaged in manufacture and another in mining. It is because in one case there is a market for one product only, thousands of miles away: in the other, there are markets at every door.

It appears evident that the proportion between agricultural and non-agricultural population is a measure of the values of the land, of the production, and of the labor of the farm. These values are rapidly enhanced by the increase of non-agriculturists. This is the lesson of the most authentic statistics of our own and of other countries.

A new system for the treatment of sewer-gas.

BY T. E. JEFFERSON, HUDSON, WIS.

IN this paper, which was well illustrated by diagrams, special reference was made to a series of important inventions which of late have attracted much attention both in this country and Europe. This system chiefly consists in making sewers approximately air-tight by sealing the sewer inlets so as to admit sewage, but exclude the air; making pipe connections between sewers and buildings, and different heating-apparatus arranged to admit the in-flow of atmosphere and the products of combustion into the sewer, and, at the same time, prevent the back-flow of gas; when by the connection of a powerful suction apparatus with the sewer, near its outlet, the removal of sewer-gas and smoke from furnaces and fires, and the thorough ventilation of buildings, is positively effected and regulated as desired.

By employing mechanical force for creating draught for fires, the large percentage of heat heretofore required for this purpose is retained, effecting a corresponding saving in the consumption of fuel.

The main portion of these important discoveries, including the removal of sewer-gas, and the positive means of ventilating buildings and carrying the vitiated atmosphere and poisonous vapors away from contact with the inhabitants, was recently made by Hon. John Comstock of Hudson, Wis., and first introduced in one of the districts of the city of Paris, France, during the present year, where its great utility and practical success are fully demonstrated.

List of other papers.

THE following papers were also read in this section: Building associations, by *Edgar Frisby;* and Health foods, by *T. S. Haight.*

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Hyperelliptic functions. — M. E. Wiltheiss starts out from a memoir of Prof. Kronecker's which appeared in the *Monatsberichte* of the Berlin academy for the year 1866, in which a method was developed for obtaining the parameters τ_{ik} of those theta-functions, which, for a certain definite transformation, remain unaltered. Prof. Kronecker started out from a purely algebraical stand-point, and solved the equations which connect the original and the transformed parameters τ_{ik} and τ'_{ik}. Corresponding to the transformation of the theta-functions, there is a transformation referring to the integrals belonging to these functions. Noting this fact, the author of the present paper has arrived at these singular values of the τ_{ik} in another manner, and his results bring into evidence a certain property which is analogous to the complex multiplication of elliptic functions. The author confines his attention solely to the theta-functions of two variables. — (*Math. ann.*, xxi.) T. C. [214

Curvature of surfaces. — M. Rud. Sturm has given here a very interesting theorem analogous to Gauss' well-known theorem concerning the measure of curvature at a point on a surface. Gauss' theorem, stated briefly, is, that if a curve p enclosing an area F is drawn around a point P of a surface, and if a corresponding curve p' enclosing an area F' is traced out on a sphere of radius unity by the extremities of radii drawn parallel to the normals to the given surface at each point of p, then the limit value of the ratios of F' and F will be equal to the inverse product of the radii of curvature R_1, R_2, of the given surface in the point P. M. Sturm's theorem is, that if the curve p is cut out of the given surface by a sphere whose centre is at P, then the mean curvature, viz., $\frac{1}{2}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$, is equal to the limit value of the ratios of the two perimeters p and p'. — (*Math. ann.*, xxi.) T. C. [215